Chapter 2

Risk Management

Risk measurement has a crucial role in the overall risk management process. It goes hand in hand with risk identification. It provides the basis for evaluating and selecting risk control and insurance alternatives.

We can quickly establish the risk measurement risk. It is to find out the likely and indirectly in lost earnings or other implications. Usually there is an inverse relationship - it is quite different for different types of risk.

Early in the development of risk management, the academic world projected into it a rather inflexible statistical approach based on measuring past losses and applying well developed statistical techniques. The problem has been that commercial management has accepted conclusions developed in this way without always understanding the assumptions on which they are based or recognizing the uncertainties that can affect them.

The practical implications for the risk manager are:

1. the need to be familiar with the main statistical methods, their uses and limitations;
2. the ability to understand the underlying risk problem that he or she is working on - and produce a simple conceptual model;
3. to use this conceptual model as a basis for collecting the appropriate data and estimating the cost of future risk events both possible and probable;
4. to remember that his or her conceptual model is both an abstraction and a simplification;
5. to be aware of changing factors in the world that could make both model and statistical work inaccurate.

WHAT TO MEASURE

When approaching risk measurement we must address the question "What are we trying to measure?"

1. Probability (or frequency).
2. Severity - likely severity;
   possible severity.

We can study severity with some success and objectivity. We can measure the frequency of what has happened but it is difficult to apply this information with confidence to predict the future.

We will have an actual loss curve - size of loss plotted against frequency.
We can estimate expected loss curve.

Risk management is difficult (but we can improve our skill with practice and feedback). Therefore, we should keep full records of calculations so that we can then check predictions against actual results and account for differences. It is important to include all assumptions in

presentation and make sure that all decision-makers understand them. Equally the temptation to make facts fit the theory needs to be resisted. After all, if our calculations disagree with actual results, we are wrong.

Therefore study the differences it will help us to get it right the next time.

Frequency

There is a relationship between frequency and severity:

1. Small regular loss:
   - sufficient size of sample needed;
   - we can then say: if the world does not change this will probably happen.

   To measure the future we need to know:
   - size of error if no change;
   - areas of possible change;
   - extent of possible change.

2. Medium irregular loss:
   - what could happen?
   - how often?
   - what can we do about it?

3. Large very rare loss:
   - what would happen?
   - how much could it cost?
   - how will we finance it?

Practical risk measurement or the estimation of the future financial cost of risk consequences is difficult because of the shortage of practical guidance to cover individual risk situations. The best method for a risk manager to gain competence is by practice. To learn in this manner it is essential to:

- keep accurate notes of how data was collected, copies of all calculations and a record of all assumptions;
- compare the actual outcome in terms of losses with the projected or forecast;
- study the difference between expectation and result and find the reasons;
- decide whether any changes in method are needed.

PREPARING AND USING STATISTICS

In endeavouring to measure risk and to make risk management decisions, risk management advisers will therefore often have need to prepare and use statistics. Some statistical knowledge will be of considerable value in ensuring that statistics are relevant and properly used.

Managers generally tend to divide into two groups:

1. those who trust and perhaps rely too much on statistics without either fully understanding their basis or questioning their relevance and use; and
2. those who are very cynical about statistics and believe that they can be used to prove

anything.

As might be expected the truth lies between these two groups. If statistics are not properly prepared, their relevance carefully considered and attention paid to all of the factors, then they may be a factor in the taking of wrong decisions. Failure to use statistics because they are sometimes abused results in not taking advantage of a valuable tool.

When statistics are used it is essential to start by considering the problem that requires their use. It may be a question of trying to reduce losses in which case we will need to ask:

1. What do we know about the losses? How do they arise? What are the causes? What can we do about them?

(If this is not done there is a risk that the statistical survey is incomplete, with extra work required later.)

2. Consider what information is readily available, how it was prepared, how relevant it is, how accurate it is and above all who prepared it and why.
3. Decide what we want to know and consider who will extract and summarise the data.

There is a very strong case for doing the work oneself. In extracting data, for example from loss reports, where much additional information is available in the reports will be possible for the risk management adviser to gain a much broader insight into what is happening and may reveal factors for review that had not been previously recognised. It also avoids the possibility of an unskilled clerk not noticing factors of consequence. Even where a computer survey is done, it will often be worthwhile to take out, read and review a number of loss files.

Some of the factors that could be relevant in analysing loss causes would be type of loss, place of loss, time of loss, nature of operation availability of equipment etc. In analysing the individual loss, we will usually find that there are multiple causes and these causes will have had two effects; some will factors relating to occurrence of loss, that affect whether others will affect its severity.

The difference in circumstances between a small and a very large loss are often marginal - in a fire it might be availability of good fire fighting equipment and personnel or the presence or absence of flammable stores (that are seasonal for example).

All sorts of implications flow from such circumstances. A very large loss (or in its absence) may create an unusually high (or unusually low) average. In terms of presentation and action decisions this problem can be dealt with by also analysing large losses and then either presenting them separately or adding a prominent footnote to presented statistics drawing attention to the big loss.

Statistical limitation and problems

Some of the problems is using statistics are:

- collecting relevant data may be difficult or impossible;
- available statistics may not be relevant;
- basis of preparation of statistics may not be known or may have changed over period covered;
- no causal co-relation may exist between factors presented (i.e. the relationship may be completely accidental);
- sampling may be inadequate, inconsistent or not random;
- projection: continuation of past trend (especially straight line) unlikely;

- average can hide significant dispersion;
- percentages may suggest trends in individual parts that are not existent;
- detail may imply accuracy that is not present;
- parallel use of data prepared on quite different bases.

Where percentages are used, it is desirable t include some numerical information as well. For example a type of loss may fall as a percentage whilst increasing numerically. This could happen in tow circumstances particularly:

1. when the overall total of losses goes up sharply; or
2. when one or more other types of loss, or a new type of loss, grows rapidly

When extracting figures, it is important to ensure an open approach, rather than seeking confirmation for an existing view. The classic "null hypothesis", where information is sought to **disprove** one's hunch, may be a doctrine of perfection, but a preconception leading to selective data gathering can result in nothing but the (often useless, sometimes dangerous) self-fulfilling prophecy. Further, one must bear in mind that an apparent relationship may be purely fortuitous, rather than causal.

A simple illustration: a large company decides to phase our Cavaliers from their fleet, and replace by Rovers; a suspicion arises that the Rovers are more accident prone. Is the Cavaliers safer? Crude figures may well show an overall increase in claims, with more falling to Rover than Cavalier drivers. If one stops there, the hunch is supported. However, an attempt to disprove the link will lead to seeking out mitigating and differing circumstances; perhaps, the more senior staff (with driver children in late teens and 20s) have been given the new range of cars first, while middle management (with children too young to drive, share only with an adult partner) may still retain Cavaliers? To achieve a meaningful comparison (and of course, there may in fact be no appreciable difference in the safety of these two cars) a whole new and wider investigation than mere loss reporting will be required.

Summary: the use of statistics

1. Review available statistics
   - Who prepared?
   - For what purpose?
   - When?
   - How were they collected?
   - Has there been any change in basis?
   - Is there any detectable bias in presentation?
   - Is there any motivation for bias?

2. Preparation of statistics:
   - Determine what is needed;
   - Review what data is available;
   - Build a simple mathematic model of relationships;
   - Avoid unrealistic detail (three significant digits normally adequate, use of more than four often unrealistic);
3. When analysing statistics:
   - Take note of any evident trends;

- Try to find realistic explanation for trend;
- Consider any current trends that are not yet apparent;
- Don't brush aside any inconsistencies (let doubts nag);

4. In presenting statistics:
   - Avoid unnecessary detail;
   - Limit number of significant figures per number to 3 or 4;
   - Make sure conditions of presentation are clearly stated;
   - Take care to ensure decision makers understand implications;
   - If conditions have changed since statistics were prepared, say so.

The importance of time is often not fully appreciated. Newer figures are more relevant than older figures. Sometimes this aspect is dealt with by weighting the figures before averaging so as to give greater emphasis to newer figures.

It is desirable to have a sufficiently long time base so as to produce meaningful figures - the smaller the "population" of figures the more likely there will be bias. When reviewing risk finance figures, it is important to bear in mind both inflation and volume of exposure. Inflation can be dealt with by use of an appropriate index (as close as possible to the kind of loss or other money related figures) using different multipliers for successive years so that all the losses etc. are expressed at current values. Similarly if one is reviewing losses of a fleet of motor vehicles, ship or aircraft - then to get comparable frequencies one needs to work in vehicle years, ship years and aircraft years rather than just years.

STATISTICAL TECHNIQUES

In this as in other areas much of what needs to be done is really common sense but there are a number of statistical techniques that can help. Several relate to the relationship between probability of occurrence and the likely value - in risk terms between probability of loss and its severity. The most common distribution of values is a normal distribution which is bell shaped - see diagram. Although it is not usually applicable to a loss measurement/frequency situation.

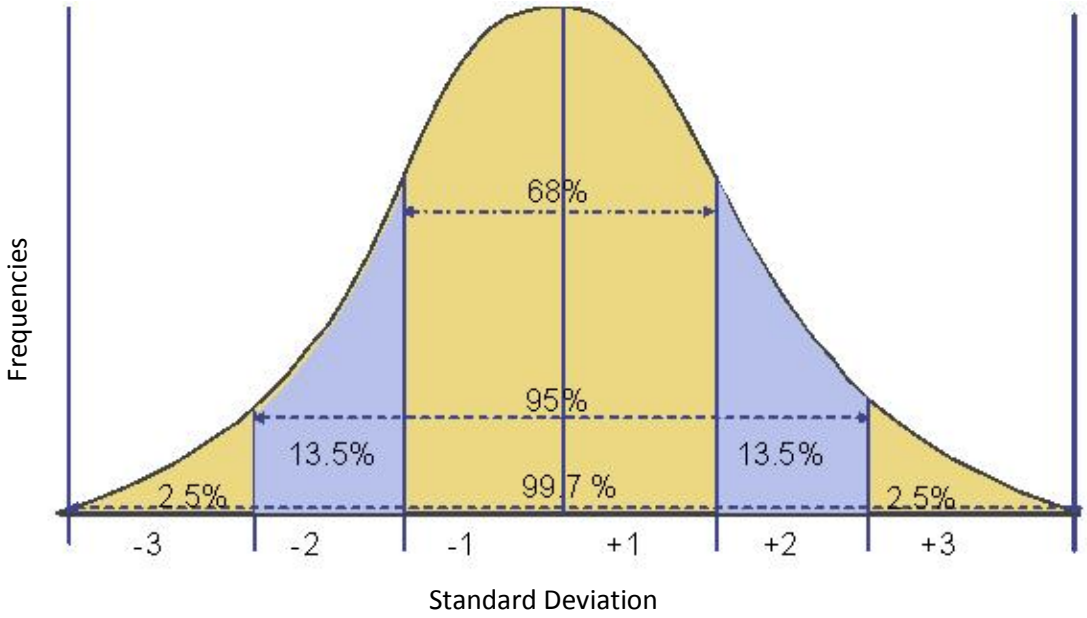
Definitions

Arithmetic mean	average number
Geometric mean	(more appropriate for continuous percentage increase) Where n = numbers multiply together all numbers then derive nth square
Harmonic mean	(to produce average prices, speeds etc) Divide number of numbers by sum of reciprocals of each figure
Median	number which is halfway between top and bottom of list of numbers
Standard deviation	shows how values are dispersed from the mean procedure for calculation 1. determine means 2. subtract each number from mean and square the result

3. add resulting numbers and divide by the number of items.
4. find square root of that number

Standard error of the means used for calculating accuracy of a sample
standard deviation divided by square root of the number of the sample

Coefficient of variation used for comparing two distributions of results which are in different values
arithmetic mean divided by standard deviation



Reference:
http://www.cmtc.com/blog/bid/137779/Continuous-Improvement-How-Six-Sigma-Ensures-Quality-Part-4

From quite small samples it is possible to calculate a figure distribution with a large degree of confidence as shown in the normal distribution diagram, with 95 per cent of figures within 2 standard deviations. The definitions give some of the most commonly used terms. Another distribution, the Poisson distribution, is often applicable to the possibility of an event occurring.

Where a normal distribution applies it is possible to calculate the accuracy of a sample by using the formula for standard error of the mean (see definitions). This permits either:

1. a calculation of how significant our existing sample is and how much reliability we can place on it; or
2. a calculation of how big a sample we need o reach a particular level of expected accuracy.

When collecting samples they need to be random, otherwise there will be bias in the result. Often selection by time will produce a random sample but there can be inadvertent bias for example if the period includes an unusually high or low level of activity or in looking at weather related losses. Care in thinking whether the sample is random and why will often produce a better view of the risk.

Of overriding importance for the RM adviser is the worst case situation. Statistically derived averages which are used to predict expected losses can give a complacent view. Looking at the largest loss experienced and considering what could have been worse is one approach - one also needs to look at other loss situation that could cause large losses.

The technique of creating a conceptual mode can be helpful but it is essential to look also at special situations that might not be included in the model.

Presentation of statistics to management is one of the key areas of a risk management advisers work. The innocent or knowing misuse of statistics is the cause of many bad decisions by management. It is essential to make sure sources are shown especially where they have different levels of accuracy and confidence.

A couple of examples may illustrate this point. Some years ago an executive summary on the risks of nuclear power presented the fatality risk in terms of annual probability in a table that included motor accidents, lightning and nuclear power. The fatality risk for motor vehicles and lightning was statistically derived from a large base of happenings - that for nuclear power was based on a theoretical reliability analysis using Mort techniques.

A major hazards study in the UK calculated the risk of an airliner falling on a chemical plant in South Lancashire by dividing the number of aircraft accidents in the UK by the land area of the UK. South Lancashire has several airways above it and therefore a much higher than average risk than the UK overall average.

In both cases stating even simply the method would alert management and a critical view would notice the wrong assumption. Our summary of the use of statistics sets out the key points.

Often a thoughtful pragmatic approach can give much better results. Three connections that are invariably needed in property risk measurement are described in the checklist entitled Using loss experience statistics. All of them relate to changes in the risk that can be measured.

Assumptions of statistics

All statistics include basic assumptions. Make sure you know and understand them, read the footnotes.

When using different sources, try and bring them to a common basis and state your assumptions.

1. Inflation - the loss occurring this year that is identical to a loss that happened say four and five years ago will cost more because of inflation. It is essential to find an appropriate measure of inflation. This may be motor repair costs for a motor accidental damage. In the case of motor third party liability there is usually an additional inflation factor in the increase in size of court awards over and above any more inflation element (this is often called "social inflation").
2. Exposure in units - if there are more vehicles operating or the total mileage has increased the exposure base of a risk will have increased. Here estimated miles or number of vehicles compared with whichever old year's losses are being considered will permit an appropriate correction factor for old year losses.

3. Other Exposure Factors - sometimes there has been a change in exposure which has not got a clear mathematical base for example a change in legislation or insurance wording. After the passage of time a new pattern will emerge but meanwhile a provisional adjustment will need to be made. Obviously the assumptions and the calculations need to be carefully recorded and the record kept.

These three factors will usually give corrected loss statistics year by year for a number of past years but they will not necessarily provide a good forecast for the next few years. For example loss experience may show clearly an improving trend and the reasons may be obvious. This can be dealt with by widely available statistical techniques which apply loadings varying with age of old loss results so that recent experience is more heavily represented.

In each case comparison of the various factors, interpretation of data and notes on the underlying situation will help to produce more realistic figures with all the notes kept for future comparison with actual outcome.

Checklist: Using loss experience statistics

Review available statistic

- for this operation/company;
- for this industry;
- for this country;
- international.

How do our circumstances differ?

- time;
- place
- processes/operations;
- management;
- loss control measure;
- staff/employees;
- volume sales/units.

Can we correct?

Adjust for

- volume;
- inflation;
- special circumstances (subjective).

Such approaches are particularly effective for all losses with a reasonable frequency - perhaps 50-100 or more each year. It will not work for unusual large catastrophe events although it is useful to expand the statistical base (for example - to consider the whole industry, an individual country or event the world rather than a single company).

In making the move it is essential to consider to what extent the risk is directly related to the character of the individual company and its operations. Analysis of many multinationals' loss

records shows that they tend to fall into two groups which each have significantly better or worse records than the average; the average is not represented.

There are thus two distinctly separate tasks which impinge on both risk measurement and cost of risk considerations:

1. loss experience in the category of small/medium losses; and
2. major and catastrophe losses.

CATASTROPHIC LOSSES

For the catastrophe risk the focus has to change from probable expectation to consideration of worst possible scenarios. The worst possible is being examined to make sure that the company has the ability to survive. There is no easy method of handling this problem but the main starting point should be a list of major risk events that could seriously affect assets and/or result in massive liability claims.

This list would then provide the basis for estimating the likely consequences and for contingency planning purposes. Often the first direct result of a planned approach to deciding on possible catastrophe events is a consideration of how the risk can be reduced. The sources of key big losses can be reviewed under several headings:

1. large earnings dependence (say 20 percent earnings or more) in any key building or location inside or outside the company;
2. large values at risk in single location;
3. events outside that could cause major loss of earnings, or result in large diminution of asset value or stock market valuation.

Needless to say the risk management specialist may find this area a tricky if not dangerous one. Often company executives do not want to consider the improbable major disaster. In some cases it may not be felt to be part of the risk management adviser's specific task.

Quantification in the catastrophe area is particularly difficult and it is therefore very important that:

1. a search is made for available relevant data inside and outside the company (others may have done part of the job);
2. research findings and estimates are carefully recorded and updated from time to time in the light of newly available data.

Some of the problems of quantification of liability are illustrated below.

Checklist: liability risk evaluation

We can measure property/earnings exposure with some accuracy. Liability measurement is much harder.

Whose liability?

- individuals;

- company;
- group

To whom?
- employees;
- customers
- others

Definitions of liability
- moral/legal;
- contract/cost;
- statute;
- different jurisdictions.

Is liability limited? In what circumstances?
- activity/operation;
- product/service;
- use/misuse;
- location.

(Always look at the worst circumstances.)

How does liability arise?
- failure to discharge duty of care or meet defined standard, and
- resulting event, and
- resulting loss die to failure, and
- plaintiff willing to sue and (where necessary) able to prosecute.

When will legal award be made?
- whose jurisdiction?
- how will law have changed?
- how will legal climate have changed?

How much do we have (assets) in all? That is our ultimate potential for loss

Risk relate to
- vulnerable persons or property;
- lack of control, non-compliance with procedures;
- inability to meet standards or failure to warn;
- failure to respond to complaints;
- inadequate defence.

Defence relates to
- quality of records;
- awareness of legal situations before, during and after event;
- arrangement and availability of good legal support.

Past cost of losses with updating for inflation (including social inflation), exposure in units and other exposure can form a basis. The biggest danger lies in explosive change in legal awards both in terms of breadth of liability and question of loss. Again this has to be considered two ways:

1. an expansion in the level of losses that are already occurring;
2. the development, perhaps as a direct result of legal initiative, of new areas of liability. This can include enormous awards.